

REMARKS

Reconsideration of the Application in view of the above amendment and the following remarks is respectfully requested.

The Examiner maintains her rejection of Claims 1-11 under 35 U.S.C. § 103(a) as being unpatentable over Tsuji in view of Harari.

We can not agree. The Examiner's interpretation of Tsuji is incorrect as will be clear from the following. The Examiner states that Tsuji teaches a method of manufacturing a semiconductor device comprising forming an insulating film over a substrate and refers to col. 5, line 7-10. The embodiment described is shown in Figs. 2A and 2B of the application. On line 7-10, a substrate layer 19 is referred to as an insulating film and thus must be the film referred to by the Examiner. The Examiner states that a first mask film is formed on this insulating film and specifically refers to col. 5, line 24. Lines 24-25 recite "...the resist layer 22 is exposed to light, with the aid of pattern as a first mask 23,...". Accordingly, the layer 23, shown in Fig. 2B, is to be formed on the insulating layer 19. Looking at the drawing, however, shows that layer 19 is at the bottom of Fig. 2B and that there are three intervening layers on the substrate 20, 21, and 22 as well as an air space before reaching element 23. That is because element 23 is a reticule, as is well know to those skilled in the art, which is utilized by the stepper to expose the resist layer 22 to the light shown impinging upon the reticule 23 in Fig. 2B.

Next, the Examiner states that a resist film is formed on the first mask film and refers to col. 5, line 18. Line 18 refers to a photoresist applied to the insulating film 21 (not insulating film 19 as discussed above) to form a resist layer 22. Referring again to Fig. 2B, it can be seen that resist layer 22 is formed on interlayer insulating film 21 and not on insulating layer 19 nor on the first mask 23. The Examiner now states that the resist film serves as a mask during the etching process and refers to col. 5, lines 32-35. While we agree that the resist film can be considered a mask film, in sharp contrast to the "first mask" (not first mask film) 23, this does not fit in with

formation of the other elements of the claim referred to above that the Examiner has maintained.

The Examiner states that furthermore Tsuji teaches the formation of a second mask film and refers to col. 5, line 46. Lines 45-46 recite "...the second exposure is carried out on the resist film 22 with use of a second mask 31 having a pattern..". The second mask 31 is shown in Figs. 3A and 3B. Again, this is not recited as a second mask film, only a second mask, which is again a reticle which is separated from the substrate and thus not formed on the substrate. The Examiner states that Tsuji teaches a formation of a wiring layer by burying an electroconductor material in the trenches. This is true, although it should be noted that two different types of trenches are formed, discussed below. The Examiner states Tsuji discloses that the second mask is located in the same position where the next opening would be later etched. The Examiner states that given the fact that the second opening in applicant's invention is etched through the sidewalls covered with the second mask film, is the Examiner's position that Tsuji's disclosure about the position of the openings etched at the deposition of the second mask reads on applicant's limitation of "the second mask film covering sidewalls and the bottom of the trenches".

First of all, it should be clear that in the present invention the trenches are not etched through the sidewall, the sidewalls are left intact. Secondly, the only film formed by Tsuji which could meet the requirements of either the first or the second mask film of the present invention is the resist layer 22. In Tsuji, the resist layer is exposed twice by but only etched once. After the first exposure using reticle 23, the resist undergoes a heat treatment in which the area of resist exposed to light is hardened in order to decrease the solution (etch) rate of that region, see col. 5, lines 28-36. Then, the same resist layer is exposed a second time but the portion exposed to light is not subjected to a heat treatment, and therefore the resist does not undergo the change in the etch rate (see col. 5, lines 39-43). Later, during the single etch process, the areas of resist that were exposed to the heat treatment are hardened to the alkali etch material and are not removed so that a contact hole or via is formed and the sidewalls remain. At the

same time, the single etch of Tsuji dissolves the resist material that has not been hardened so that not only is a trench formed, but the sidewalls are significantly etched down so that a wiring layer can be placed above the contact hole or via. Thus, the finished contact hole is shown in Fig. 9A and the finished contact hole with the metal interconnect is shown in Fig. 9B. Comparing Figs. 9A and 9B, we see that the sidewalls 21 are at full height in Fig. 9A, but have been reduced to approximately half height in the embodiment of Fig. 9B. Both of these structures can be formed at the same time using the Tsuji technique.

In sharp contrast, the present invention utilizes two separate mask films which are formed on the substrate. We know that there are two separate mask films, because a portion of the first mask film is removed before the second the mask film is formed. This portion of the first mask film is removed during the first etching step which is followed by the formation of trenches in the insulating film exposed from the opening. The second mask film is then formed after which the horizontal surfaces thereof are removed leaving only the sidewall portions and a second etch is performed using the first mask film and the second mask film as the etching mask for etching the trenches deeper.

In summary, Tsuji shows a single mask film, resist 22, which is exposed twice and etched once whereas in the present invention two mask films are formed, each of which is exposed and etched separately. The purpose of Tsuji is to form the connecting holes or vias and connecting holes or vias with metal interconnects in the same series of steps. The purpose of the present invention is to produce a trench having a sharper vertical sidewall than available in the prior art.

As stated in previous responses, it is very important to understand the difference between a "first mask" and a "first mask film". Although they sound very similar, the term, "first mask" as utilized in Tsuji refers to the exposure mask which is mounted in the reticule on the stepper and used to expose the resist layer 22. In sharp contrast, the term "first mask film" as utilized in the present invention refers to a film which is formed on an insulating film which is in

turn formed on the semiconductor substrate or SOI substrate. Note that the claims, such as Claim 1, recite "forming a first mask film on the insulating film", (emphasis added).

One clue to the Examiner's misinterpretation of Tsuji is that the first mask 23 is recited on col. 5, lines 24-25, where as the resist which is to be formed on the first mask film, according to the Examiner, resist layer 22, is recited at col. 5, lines 16-20. Thus, in Tsuji, the resist is formed before the Examiner's "first mask 23" making it impossible for the resist film to be formed on a first mask "film".

Accordingly, Applicants believe that the application is in condition for allowance, and such action is respectfully requested.

Respectfully submitted,

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